

datron

**OPERATING MANUAL
for
DATRON MODEL 1059
DIGITAL MULTIMETER**

METEOR CLOSE

NORWICH AIRPORT INDUSTRIAL ESTATE NORWICH NR6 6HQ ENGLAND

MP MASTER



MA23498

MANUAL UPDATE SHEET

REF NO. 850035/E1

Section Amended:

Page 36 2.5.1

Should read: 21) Connect the oscilloscope to TP1 w.r.t. TP19

Page 36 2.5.1

Should read: 37) Repeat steps 34 and 36

Page 37 2.5.1

Should read: 46) Apply -1V

Page 38 2.5.2.2**

Should read: 8) 'pA' offset control, R38

Page 38 2.5.2.2

Should read: 14), adjust R46

1059 Operating Manual

Section Amended:

1. Page 6 2.36 should read:

Accuracy
 3kHz - 30kHz $\pm 0.2\% \pm 0.1\%$ F.S. (1mA & 10mA ranges only).

2. Page 18 5.31 should read:

Turn on the instrument to be checked and allow at least two hours to warm up.

The instrument should be operational, but not necessarily to full specification, within a few seconds.

OPERATING MANUAL
for
DATRON MODEL 1059
DIGITAL MULTIMETER

Instrument Designed and Manufactured by:—

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SECTION 1

INSTALLATION

1.1 UNPACKING AND INSPECTION

Note:

SHOULD YOUR INSTRUMENT HAVE BEEN SUBJECTED TO EXCESSIVE MISHANDLING IN TRANSIT THE FACT WILL PROBABLY BE VISIBLE AS EXTERNAL DAMAGE TO THE SHIPPING CARTON. UNPACK THE INSTRUMENT AND CHECK FOR EXTERNAL DAMAGE TO CASE, PUSHBUTTONS, TERMINALS ETC. IF ANY DAMAGE IS FOUND, NOTIFY THE CARRIER IMMEDIATELY.

Every care is taken in the choice of packaging materials to ensure that your new instrument will reach you in a perfect condition. Our packaging and protection are adequate to cater for all the normal hazards of road or rail transit. Special export packaging is provided for overseas orders.

1.2 INSTALLATION

The instrument is housed in a robust, heavy-gauge aluminium case so designed to withstand the rough knocks of industrial usage. A detachable supply lead, comprising two metres of 3-core P.V.C. sheath cable permanently moulded to a fully-shrouded 3-pin cable socket fits at the rear of the instrument and should be pushed firmly home. Connect the supply lead to a 3-pin plug (fused 1 amp), ensuring that the instrument case is earthed via the Yellow/Green earthing wire.

1.2.1 Voltage Tappings

The instrument is packed ready for use with 205V to 255V, 48 to 440 Hz supplies, unless otherwise specified at the time of ordering. For operation from supplies in the range 105V to 127V, 48 to 440 Hz, it is necessary to alter the connections to the primary windings of the mains transformer. Remove the top cover and note the tags mounted on the printed circuit board adjacent to the mains transformer.

FIG 1:1 Mains transformer tappings

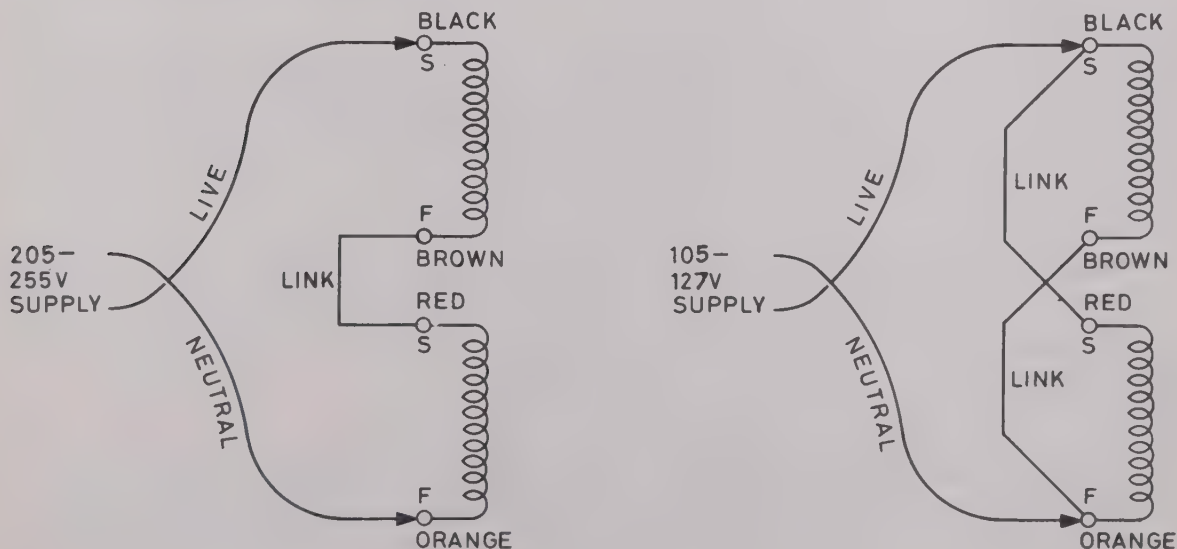


Fig 1:1

Mains Transformer Tappings

SECTION 2

GENERAL DESCRIPTION AND SPECIFICATION

2.1 FEATURES

The model 1059 is a digital multimeter combining the high performance of a sophisticated DVM with the low cost of a conventional multimeter. Within the main frame is provided full D.C. voltage measurement capability, true R.M.S. A.C. measurement, resistance measurement, D.C. and true R.M.S. A.C. current measurement.

2.1.1. Options

B05 Electrically isolated 3 state BCD output.

R04 External reference, a 4 wire, 4 quadrant reference input with connector mounted on rear panel to provide ratio measurement capability.

2.2 ELECTRICAL DESCRIPTION

This instrument comprises a precision fully floating isolation amplifier with electronically switched gain ranges providing a 1 volt full range output which is converted to a digital reading by the analogue to digital converter. A.C. voltage measurement is achieved using a true R.M.S. A.C. converter which converts A.C. signals to D.C. and applies the D.C. to the analogue to digital converter. The input to the A.C. converter can be either A.C. or D.C. coupled. Fig. 2:1 illustrates the various sections.

2.2.1 D.C. Isolator Amplifier

Accurate D.C. voltage measurement can only be achieved using an instrument of high resolution, which maintains its accuracy by negligible signal loading and by the rejection of errors due to external effects. The floating isolation amplifier performs this task and has excellent D.C. offset performance (typically $0.2 \mu\text{V}/^{\circ}\text{C}$ and $2\text{pA}/^{\circ}\text{C}$). The whole amplifier, including its power supplies follows the input signal, thus providing exceptionally high input impedance ($> 10,000 \text{ M}\Omega$) and very good rejection of common mode signals due to its high common mode input impedance.

2.2.2 AC Converter

The true RMS sensing AC converter is of unique design and capability. Unlike a thermal converter the electronic unit meets its linearity (% FS) specifications over the full range of input signals from zero to full scale. It has a very fast response and is less susceptible to temperature variations than its thermal counterpart.

2.2.3 Resistance Converter

Resistance measurement is achieved by passing the current from a precision current source through the unknown resistance and sensing the voltage developed across that unknown with the D.C. isolator amplifier.

2.2.4 Current Converter

For current measurement, switched precision current shunts are fitted internally. The unknown current is passed through these and the resulting voltage developed is fed either to the D.C. isolation amplifier or to the RMS A.C. converter, to provide either a D.C. or an A.C. measurement. The current shunts are protected by an electronic circuit for low overloads and by a very fast acting fuse and clamp circuit for high overloads of up to 300A.

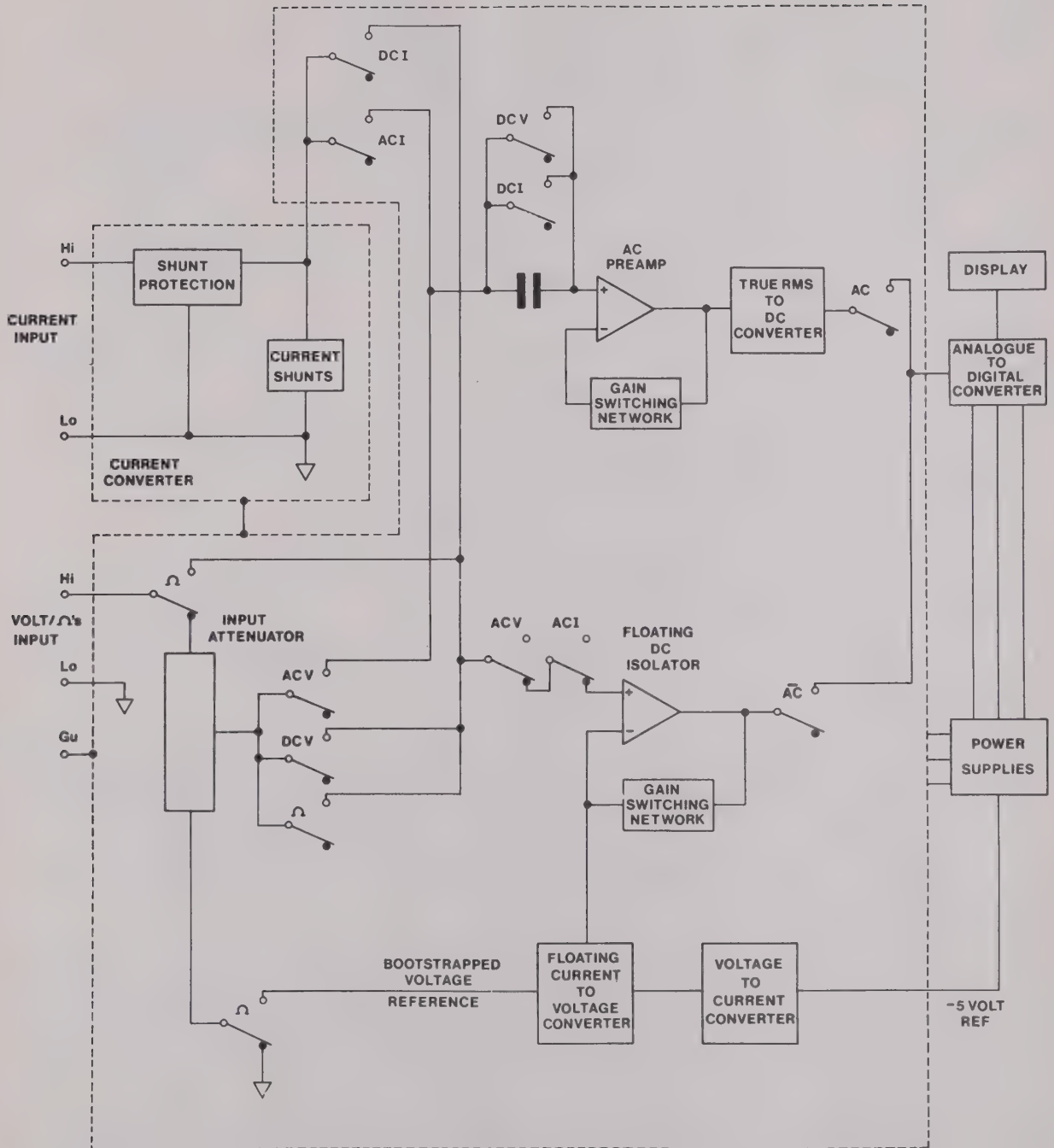


FIG.2.1
SIMPLIFIED BLOCK DIAGRAM

The circuit for converting the analogue signal to digital form was chosen to provide, amongst other things, a high level of noise rejection. To perform accurate low level DC measurements it is necessary to reject both normal and common mode noise voltages. The effect of common mode noise voltages is greatly reduced by using Guard Shield techniques and any remaining normal mode noise is rejected by using a technique similar to the commonly used dual slope integration method of analogue to digital conversion.

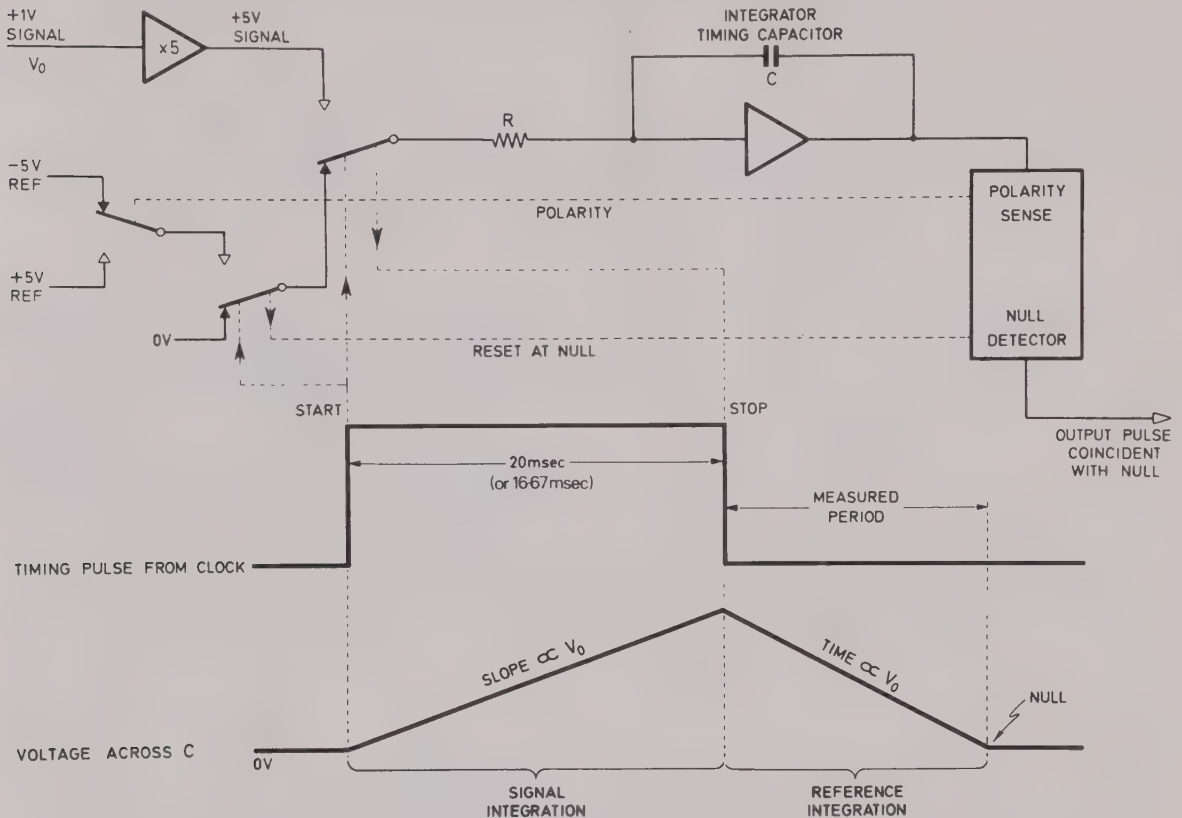


FIG. 2:2

Fig. 2:2 shows a simplified functional diagram of the converter section. The purpose of this part of the circuit is to convert the input signal V_0 into a time-period directly proportional to the input voltage. The 1-volt signal is first amplified to give a 5-volt signal. This is applied via electronic switching, controlled by timing pulses, to resistor R connected to the virtual-earth input of a very high-gain integration amplifier. Capacitor C always starts the integration period from a state of zero charge, and now commences to charge up at a rate proportional to the input voltage. The signal integration period lasts for $20msec$, during which time capacitor C acquires a charge proportional to V_0 .

At the end of $20msec$, resistor R is disconnected from the incoming signal and transferred to an accurate 5-volt reference source of opposite polarity to that of the input signal. The length of time it takes to discharge capacitor C to zero volts is directly proportional to the state of charge acquired during the signal integration period which, in turn, is proportional to the input voltage V_0 . The instant that the voltage across capacitor C reaches zero is signalled by a pulse from the Null Detector, and fed as a strobe pulse to the display circuitry. The same pulse is used to disconnect the reference voltage, and reset the circuit ready for the start of the next timing pulse.

In the event of capacitor C acquiring a reverse charge during the signal integration period, the Null Detector incorporates a polarity-sensing circuit; this ensures that the reference potential is always of the correct polarity to discharge capacitor C and thus allows measurements of either polarity without reversing the input signal.

2.2.6 External Reference Buffer

The reference buffer or ratio option is a precision isolation buffer which takes a signal in the range 0.3 to 2.0 volts, amplifies it with a gain of 5 and drives the reference circuitry of the analogue to digital converter in place of the internal reference. The buffer is an active 4-wire device providing 1000 Megohms input impedance and a common mode capability (relative to signal input L_o) of 10 volts. The reference input may be of either polarity as internal circuitry senses the polarity of both the signal and reference inputs and enables 4 quadrant ratio measurements to be made.

2.3 SPECIFICATIONS

2.3.1 General

Power Supply	205 — 255 or 105 — 127 volts, 48 — 440 Hz. Specify line frequency and voltage when ordering. Consumption is approximately 12 VA.
Operating Temperature	0°C to 50°C.
Storage Temperature	—25°C to +70°C
Dimensions	H = 90 mm (3.5"), W = 440 mm (17.25"), D = 343 mm (13.5").
Weight	5.5 kg (12 lbs).
Rack Mounting	"Ears" mounted on side of instrument.
Specification Validity	For 6 months over 18–28°C or as described.

2.3.2 D.C. Voltage Measurement

Ranges	100.000 mV, 1.00000 V, 10.0000 V, 100.000 V, 1000.00 V.
Overrange	100% (i.e. 199999 full scale) on all ranges except 1000.00 V.
Accuracy	6 months, 18–28°C, after mV and pA offset adjustment, all ranges. $\pm 0.01\%$ reading $\pm 0.001\%$ FS $\pm 1 \mu\text{V}$. Add 0.15 ppm/V above 300 V.
Temperature Coefficient	$\pm 1/10$ (of above accuracy rating)/°C $\pm 0.4 \mu\text{V}/^\circ\text{C}$.
Stability	After six months use better than 100 ppm per year.
Short Term Accuracy	As above but $\pm .005\%$ reading, 90 days, 22–24°C.
Common Mode Rejection (1 k Ω Source Unbalance)	DC > 120 dB AC > 140 dB at 50 Hz.
Series Mode Rejection	80 dB at 50 Hz increasing at 40 dB/decade.
Setting Time (to .001%)	< 500 mS
Read Rate (externally triggered)	Maximum independent reading rate with a nominal full range signal is 1.5/S.
Read Rate (internal)	2.5/S.
Maximum Input Voltage (without damage)	Signal Hi to Signal Lo 1000 V (Any Range). Signal Lo to Guard 250 V Guard to Earth (Case) 500 V
Input Resistance (Rin)	100 mV and 1V ranges (up to 2V) $R_{in} > 10,000 \text{ M}\Omega$. 10 V to 1,000 V ranges $R_{in} = 10 \text{ M}\Omega \pm 0.1\%$
Input Current	< 50 pA drifting at typically 3 pA/°C.

2.3.3 AC Voltage Measurement

Ranges	1.00000 Volts, 10.0000 Volts, 100.000 Volts, ~~1000.00~~ 700.00 MAX Volts.
Overrange	100% i.e. 199999 FS except 1000V.
Accuracy	6 months duration, 18–28°C, $< 3 \times 10^6$ Volt. Hertz. DC and 40 Hz — 3 kHz $\pm 0.1\%$ reading $\pm 0.05\%$ FS 3 kHz — 30 kHz $\pm 0.2\%$ reading $\pm .1\%$ FS Add 0.2 ppm/V above 300 V.
Temperature Coefficient	1/10 (above accuracy rating)/°C.
Common mode Rejection	1 k Ω unbalance in Hi > 100 dB @ DC — 60 Hz. 1 k Ω unbalance in Lo > 60 dB @ DC — 60 Hz.
Settling Time	1 Sec.

Maximum Input Voltage	1000 V peak on any range, $< 3 \times 10^6$ Volt. Hertz. Measures AC component with up to 1000 V DC bias on any range, (AC coupled).
Conversion Type	True R.M.S. (AC coupled or DC coupled).
Input Impedance	1000 M Ω shunted by 100 pF on 1 V range. 10 M Ω shunted by 150 pF on other ranges.

2.3.4 Resistance Measurement

Ranges	1.00000 k Ω 10.0000 k Ω , 100.000 k Ω , 1000.00 k Ω , 10.0000 M Ω .
Overrange	100% on all ranges.
Accuracy	6 months duration 18–28°C 1K Ω $\pm .01\%$ R $\pm 0.005\%$ FS. 10k Ω to 100 k $\pm 0.01\%$ reading $\pm 0.002\%$ FS. 1000 k Ω $\pm 0.03\%$ reading $\pm 0.002\%$ FS. 10M Ω $\pm 0.5\%$ reading $\pm 0.002\%$ FS.
Temperature Coefficient	1/10 (above accuracy rating)/°C
Input Protection	250 V DC or r.m.s.
Current Through Unknown	1 k Ω 100.000 μ A 10 k Ω 100.000 μ A 100 k Ω 10.0000 μ A 1000 k Ω 1.00000 μ A 10 M Ω 100.000 μ A

2.3.5 D.C. Current Measurement

Ranges	1.00000 mA, 10.0000 mA, 100.000 mA, 1000.00 mA.
Overrange	100% (i.e. 199999 full scale) on all ranges
Accuracy	6 months at 23°C $\pm 5^\circ$ C 1 mA to 100 mA ranges $\pm 0.015\%$ R $\pm 0.001\%$ FS. 1000 mA range $\pm 0.03\%$ R $\pm 0.002\%$ FS (add 0.05% R above 1000 mA)
Temperature Coefficient	$\pm 1/10$ accuracy rating /°C.
Settling Time	< 500 mS to specified accuracy.
Shunt Resistance	1 mA range 500 Ω + 0.47 Ω 10 mA range 50 Ω + 0.47 Ω 100 mA range 5 Ω + 0.47 Ω 1000 mA range 0.5 Ω + 0.47 Ω
Input Protection	250 V DC or RMS AC (non-inductive) sources.
Current Overload	Up to 2.5A : automatically reset after 10 seconds. Short term: 5A for 2 seconds. For input currents greater than above protection is provided by internally fitted fuse. (For replacement see Section 3.6.3).

2.3.6 AC Current Measurement

	As for DC current except: –
Accuracy	6 months at 23°C $\pm 5^\circ$ C. DC + 40 Hz – 3 kHz $\pm 0.1\%$ R $\pm 0.05\%$ FS. 3 kHz – 30 kHz $\pm 0.2\%$ $\pm 0.1\%$ FS. (1 mA & 10 mA ranges only).
Crest Factor	5:1 at full range. 2.5:1 at 100% overrange.
Settling Time	<1 second to specified accuracy.
AC Coupling	Large DC offsets may cause the overload protection to operate as the AC coupling is provided after the current shunts.

2.3.7	External Reference (Ratio)	Option R04.
	Capability	DC/DC, AC/DC, OHMS/DC, CURRENT/DC.
	Type	4 wire 4 quadrant
	Ranges	SIGNAL: 1 Volt Signal input as function and range. Reference input ± 0.3 volts to ± 2.0 Volts
	Accuracy	$\pm X\%$ reading $\pm Y \cdot \frac{1}{\text{Ref}} \% \text{ FS}$ Where: X = appropriate % reading spec. for signal input range and function selected. Y = appropriate % full scale spec. for signal input range and function selected. e.g. For DC signal input: $-\pm 0.01\% R \pm 0.001 \frac{1}{\text{Ref}} \% \text{ FS}$
	Temperature Coefficient	1/10 (above accuracy rating)/°C.
	Input Resistance	1000 M Ω Differential. 100 M Ω Ref. Hi to Signal Lo.
	Common Mode Voltage	± 10 Volts maximum
	Common Mode Rejection	> 60 dB DC –60 Hz.
	Series Mode Rejection	36 dB @ 50 Hz increasing at 40 dB per decade.
	Maximum Reference Input (without Damage)	250 Volts DC or r.m.s.
	Response Time	< 1 sec to 0.1% Final Value.

2.3.8	BCD Output	Option B05 gives reading, range and function 1.2.4.8 +ve true TTL compatible code. External Hold and Read Command facilities are provided together with signal integrate and print command output flags. FAN OUT: 2 TTL LOADS. FAN IN: 1. Provided as standard is the facility for turning all the outputs into a high impedance condition (i.e. “OFF”) and disabling all inputs. The option is electrically isolated from the signal input terminals and referred to power ground via a 100 K Ω resistor.
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SECTION 3

CONTROLS AND OPERATION

3.1 INPUT CONNECTIONS

Five terminals are located on the front panel marked Volts/Ohms Hi, Lo & Guard, and Current Hi and Lo, coloured Red, Black, White, Brown and Blue respectively. The terminals are mounted on a standard 0.75 inch (19 mm) spacing and connection may be made using 4 mm single or double banana plugs.

In order to minimise thermal E.M.F's, copper wire should be used for connecting to the instrument and preferably passed through the side entry holes of the Hi and Lo terminals, although this precaution is usually only of importance when measuring at microvolt levels.

NOTE:

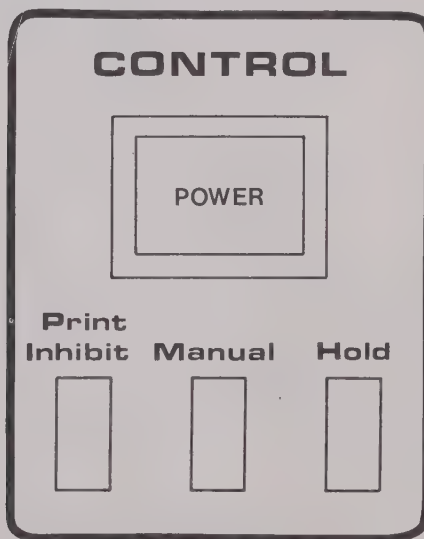
The following input voltages must not be exceeded under any circumstances:—

Volts	Hi to Lo	1000 Volts DC or peak AC.
Ohms	Hi to Lo	250 Volts DC or r.m.s.
Volts/Ohms	Lo to GUARD	250 Volts DC or r.m.s.
GUARD to EARTH		500 Volts peak.
Current	Hi to Lo	250 Volts DC or r.m.s.
Current	Lo to GUARD	250 Volts DC or r.m.s.

Full details of the recommended methods of making connection between the input terminals and the circuit under test are given in Section 3.6.1.

3.2 PUSH BUTTONS

The push buttons are in three groups labelled RANGE, FUNCTION and CONTROL. In the FUNCTION and RANGE groups, LED indicators are provided beneath the push buttons to enable the user to see at a glance which function and range has been selected.



3.2.1 Control Group

POWER

This push button switch with alternate ON/OFF action is mounted in the centre of the front panel. It isolates the mains supply live from the instrument with the exception of the mains fuse, socket and filter which remain live unless the supply lead is disconnected.

HOLD

The instrument normally free runs taking about 3 readings per second, but on depressing the HOLD button the internal command mechanism is disabled. Any conversion in progress is completed and displayed: the display being held until HOLD is released or a COMMAND initiated either via the BCD connector or the MANUAL push button.

MANUAL

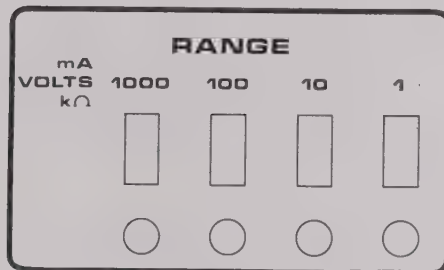
This is a momentary action button whose operation is only enabled when the HOLD button is depressed. Upon pressing the MANUAL button a single reading is initiated, followed by a print command output at the BCD connector (if option B05 is fitted). Care should be taken since contact bounce in the MANUAL switch can cause double commanding.

PRINT INHIBIT

With option B05 PRINT INHIBIT turns all the outputs to 'OFF' or a high impedance state and disables the command control lines.

3.2.2 Range Group

There are four range buttons which are interlocked such that only one at a time can be depressed. The push buttons are marked as follows:—

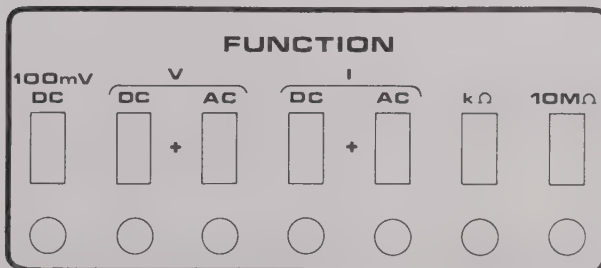


Note:— 1A and 1M are displayed as 1000.00 mA and 1000.00 Ω respectively.

OVERRANGE is signified by a 1 being illuminated at the left of the normal display. 100% overrange permits a maximum display of 199999 except on the 1 kV range where it is limited by a maximum input voltage of 1000.00 volts. OVERLOAD results in blanking of the digits above 100% overrange.

3.2.3 Function Group

Seven buttons are provided in this group interlocked such that the following functions may be selected:—



100 mV DC Depressing this button cancels the previous function, inhibits all switches in the RANGE group and provides the user with a sensitive DC range enabling the measurement of voltages down to 1 μ V to be made.

VOLTAGE Two buttons are provided for this function, one for DC voltage and the other for R.M.S. AC voltage measurements. They may be selected singly, or in cases when the R.M.S. measurement of an AC voltage with a DC component is required, the switch interlocking allows the two buttons to be depressed simultaneously. When either of these buttons is depressed the range is that selected by the appropriate button in the range group.

CURRENT Again two buttons are provided and operation is as for the two voltage buttons.

OHMS Depressing this button cancels the previous function and provides the user with whichever resistance range is selected in the RANGE group.

10 M Ω Depressing this button cancels the previous function, inhibits all the switches in the RANGE group and provides the user with a high resistance range enabling the measurement of resistances up to 20 M Ω to be made.

3.3 μ V OFFSET This screwdriver operated multi-turn preset control enables the instrument to be zeroed with zero input signal applied to the 100 mV DC range. The span is approximately $\pm 80 \mu$ V and it can then be used very effectively to compensate for external offsets as well as the very low, long term drift of the instrument. (See zeroing procedure, Section 3.6).

3.4 pA OFFSET This screwdriver operated multi-turn preset control enables the input current of the instrument, (typically 30 pA), to be minimised on the DC voltage ranges. This Control is particularly useful when measuring from very high source resistances. It can be conveniently set up by using it as a 10 V DC range zero adjustment with a short-circuited input. (See zeroing procedure, section 3.6).

3.5 REAR PANEL CONTROLS

POWER FUSE The supply to the mains transformer primary windings is protected by a 100 mA rating 20mm x 5 mm glass cartridge fuse of the type variously known as “delay”, “slow blow”, “time lag” or “anti-surge”. The fuse may be inspected and, if necessary, replaced by unscrewing the cap of the fuse-holder located on the rear panel of the instrument.

Suitable replacement fuses are:—

Belling Lee L2080/100
Radiospares A/S Fuse 20mm 100 mA
A.F. Bulgin Type F286/100 mA

REFERENCE INT/EXT (Option)

This slide switch enables either internal or external reference to be selected if Option R04 (external reference or Ratio) is installed. A 5-pin socket allows application of external reference signals.

BCD OUTPUT (Option) A 50-way AMPHENOL “BLUE RIBBON” connector provides TTL logic level codes for reading range and function.

POWER SOCKET A 3-pin CEE regulation 250 V, 6A power socket accepts the mating plug which is integrally moulded with the power lead.

3.6 OPERATION

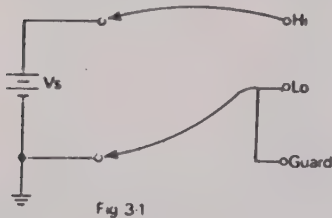
Preliminary Checks

- 1 Check that the instrument is correctly adjusted for the mains supply to which it is to be connected. See Section 1.2.1. This will be 230 V unless specifically requested to be the low voltage version.
Note: No fine tapping adjustments are required for voltages within each of the major ranges.
- 2 Connect the mains supply leads.
- 3 Switch on the supply and allow the equipment to stabilize.
- 4 Before commencing any further, read Section 2, Section 3, and in particular the Note in Section 1, page 1.
- 5 Zeroing procedure – With a copper shorting link between the voltage Hi, Lo and guard terminals, adjust the ‘pA offset’ control for a display of 0.0000 bouncing polarity on the 10V range.
Then adjust the ‘ μ V offset’ control for 0.000 bouncing polarity on the 100mV DC range. Switch back to 10V range and repeat the procedure until no further adjustments become necessary.

3.6.1 Common Mode and Guard

Common Mode Voltages are equally present on both terminals of the voltage source being measured and excessive levels, either AC or DC, can affect the measurement being made. However, sensible use of the GUARD terminal can reduce errors to a negligible level.

Note: In most measurement situations it is adequate to strap together the Lo and Guard terminals by use of the link provided and to connect the source as shown in Fig 3:1.



The disadvantage of the simple arrangement in Fig. 3:1 is that the connecting leads form a loop. If a stray alternating magnetic field from the mains transformer of a neighbouring instrument passes through the loop it will behave as a single turn secondary winding, and unwanted AC voltages will be induced into the measuring circuit.

The GUARD terminal should be used when the source to be measured presents an unbalanced impedance to the measuring terminals and Common Mode Voltages are present. In general, regardless how the Hi and Lo terminals are connected, the GUARD terminal should refer to the source of Common Mode Voltage as shown in Figs 3:2, 3:3, 3:4 and 3:5.

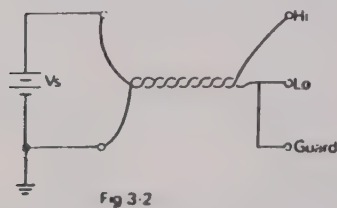
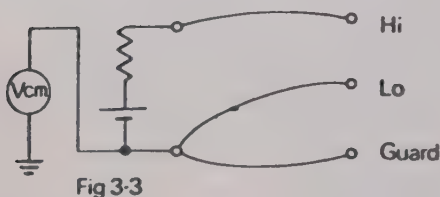


Fig. 3:2 is a better arrangement, where the twisted pair reduces the loop area and adjacent twists of the wires produce cancellation of any induced voltages.



The simple case in Fig. 3:3 allows the GUARD to be connected remotely or at the terminals since in both cases it is to the source of Command Mode Voltages.

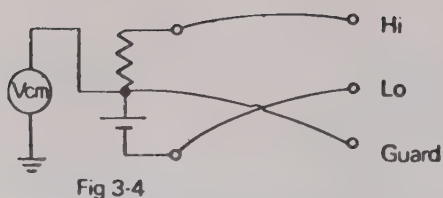


Fig. 3:4 shows a case where the Common Mode Voltage is not present on the Lo measurement terminal and should therefore be connected remotely.

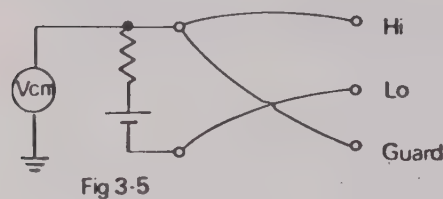


Fig. 3:5 shows an extreme situation where all the unbalance to Common Mode Voltage is in the Lo lead and GUARD must therefore be connected to Hi.

The cases above show the connections made by use of individual wires, it is recommended, however that a screened twisted pair microphone cable be used with the GUARD terminal connected to the screen.

Table 3.1 below lists the recommended types,

TABLE 3.1

Manufacture	Type	pF/Metre	Outside diameter
Suhner	G03939	65	4.6 mm
Suhner	CB04730	195	5.3 mm
Transradio	MC 02-A	115	4.4 mm
Transradio	MC 02-D	130	3.5 mm
B.I.C.C.	9442 Y	120	4.7 mm

When making a particular measurement, choose the most suitable method of connection and check that it does not involve exceeding any of the input voltages listed under Section 3.1.

3.6.2 Thermal e.m.f.

Where very low level measurements are being made, care must be taken to minimise and balance thermal e.m.f's generated in the leads. In general, the use of steel probes, croc-clips and all metals with the exception of copper should be avoided.

3.6.3 Overload Current Fuse Replacement

If the maximum input currents specified in Section 2.3.5 are exceeded, one or both of the internally fitted protection fuses will blow. If either of these fuses is blown, all ranges of DC and AC current will be disabled, and the display will read all zeros.

To replace either fuse it is necessary to gain access to the current converter by removing the bottom cover (4 screws – M3 x 10 mm).

The two fuses are then visible at the input end of the current Converter. The continuity of both fuses should be checked with no connections made to the front panel current terminals. The smaller of the fuses is contained in a printed circuit mounted fuse holder and should be replaced by a 2.0A, '20 mm' glass fuse, Belling Lee L1427A (fast blow) or equivalent. The larger fuse can be removed by releasing two screws M3 x 6 mm, and should be replaced by a 5A H.R.C. Semiconductor Fuse-Link, English Electric G.S.A.5 or equivalent. A spare G.S.A.5 type fuse (Datron part no. 920027) is fitted at the rear of the Current Converter, again secured by two screws M3 x 6 mm.

SECTION 4

OPTIONAL REMOTE OPERATION

4.1 OPTION (B05): 1-2-4-8 BCD OUTPUT

4.1.1 Description

Option (B05) enables full Binary Coded Decimal outputs describing Reading Range and Function to be obtained from a 50-way Amphenol blue ribbon connector (J5) mounted on the rear panel. The outputs are isolated from the signal input terminals and referred to earth via a 100 K Ω resistor.

Whilst it is recommended that the output digital common be referred to true earth, the input terminals may be floated as high as 500 volts relative to true earth and digital common.

The 50-way connector (J5) also provides various control lines and flags, enabling complete external control of the Analogue to Digital converter. All levels are TTL compatible, with a fan-out of 2.

4.1.2 Connections

The table below (and on the following page) lists the various functions of the pins on connector J5. BCD output numbers are given magnitudes that assume operation on the 1 V Range. Bar notation indicates that a low level (less than 0.4 V) is 'active' or 'enables' the described state.

e.g. $\overline{\text{DCV}}$ means that pin 29 is low (less than 0.4 V) when the instrument is operating in any of its DC or DC + AC voltage ranges.

J5 Pin No.	Function	Description
1	2×10^{-4}	BCD Output No.
2	4×10^{-4}	" "
3	8×10^{-4}	" "
4	1×10^{-4}	" "
5	2×10^{-3}	" "
6	4×10^{-3}	" "
7	8×10^{-3}	" "
8	1×10^{-3}	" "
9	2×10^{-2}	" "
10	4×10^{-2}	" "
11	8×10^{-2}	" "
12	1×10^{-2}	" "
13	2×10^{-1}	" "
14	4×10^{-1}	" "
15	8×10^{-1}	" "
16	1×10^{-1}	" "
17	OVERLOAD	Indicates signal greater than 199999
18	1×10^0	BCD Output No.
19	2×10^{-5}	" "
20	4×10^{-5}	" "
21	8×10^{-5}	" "
22	1×10^{-5}	" "
23	Not used	
24	Not used	
25	<u>EXTERNAL REF</u>	0 Indicates EXTERNAL
26	<u>MINUS POLARITY</u>	0 Indicates negative reading
27	<u>PLUS POLARITY</u>	0 Indicates positive reading
28	<u>OHMS</u>	0 Indicates Resistance Measurement
29	<u>DC V</u>	0 Indicates DC Voltage Measurement
30	<u>AC V</u>	0 Indicates AC Voltage Measurement

J5 Pin No.	Function	Description
31	<u>ACI</u>	0 Indicates AC Current Measurement
32	<u>mV</u>	0 Indicates mV
33	<u>DCI</u>	0 Indicates DC Current Measurement
34	RANGE A	RANGE INFORMATION
35	RANGE B	RANGE INFORMATION
36	RANGE C	RANGE INFORMATION
37	Not used	
38	FP CONTROL	Input control line
39	Digital COMMON	0 state reference
40	<u>HOLD</u>	Input control line
41	<u>COMMAND</u>	Input control line
42	<u>PRINT INHIBIT</u>	Input control line
43	SIG. INTEGRATE	Output control flag
44	<u>DELAY</u>	Input control line
45	<u>PRINT COMMAND</u>	Output control flag
46	Not used	
47	Not used	
48	Not used	
49	Not used	
50	Not used	

4.1.3 Examples of BCD Coding

Suppose the following pins of J5 are in a 1 state (greater than 2.4 V):–

3 – 5 – 6 – 9 – 12 – 15 – 16 – 20

this gives a reading of:–

Pins

3	8×10^{-4}	= .0008
5 & 6	$2 \times 10^{-3} + 4 \times 10^{-3}$	= .006
9 & 12	$2 \times 10^{-2} + 1 \times 10^{-2}$	= .03
15 & 16	$8 \times 10^{-1} + 1 \times 10^{-1}$	= .9
20	4×10^{-5}	= .00004
TOTAL =		.93684

The table below shows the state of the RANGE outputs for the seven ranges.

Pin No.	34	35	36
Range			
100 mV	0	1	0
1 V/K Ω /mA	1	1	0
10 V/K Ω /mA	0	0	1
100 V/K Ω /mA	1	0	1
1,000 V/K Ω /mA	0	1	1
10,000 K Ω	1	1	1

Now suppose pins 32, 34 and 36 are all in a low or 0 state (less than 0.4 V)

Pin 32 low, indicates that the instrument is measuring mV. Pins 34 and 36 low, with pin 35 high, indicates a full scale reading of 100.00 mV. The reading is therefore 93.684 mV.

Pins 29, 30 and 31 are merely flags indicating a particular measurement mode, and do not affect interpretation of the BCD number. Pin 17, OVERLOAD, indicates when the input signal is too high for a particular range. BCD numbers may be present even when pin 17 is in a 1 state but they must not be taken as valid though they will be accurate for numbers only slightly in excess of 199999.

4.1.4 Control Lines

Pins 40 to 45 are control lines, enabling the user to control the instrument remotely when it is used in conjunction with other equipment as part of a test system. The control input lines float to a 1 or high state if open circuit, and can be held to a 0 or low state by connecting them to pin 39, digital COMMON.

4.1.4.1 Print Command: Pin 45, PRINT COMMAND falls from a 1 to 0 state at the end of each measurement cycle, when the new reading has been transferred to the storage registers and is available at the pins of J5 in the form of steady BCD output information.

The falling voltage step available at pin 45 can thus command an external reading device to take note of the BCD output or, alternatively, the 1 state can be used to inhibit scanning of the BCD information. Since the reading is stored, it is available at any time except when new information is being transferred. Pin 45 is only in the 1 state for the duration of the transfer period, lasting about 5 milliseconds.

A logic low on pin 42 PRINT INHIBIT prevents the PRINT COMMAND edge from occurring on pin 45, thus making it easy to stop external printers etc. Pin 45 is forced to a high impedance state in this condition.

4.1.4.2 Signal Integrate: Pin 43 exhibits a high state flag while the analogue to digital convertor is acquiring its information. It is made available because its falling edge represents the earliest time at which new signal information may be applied to the input terminals without disturbing the reading in hand. It can thus be used to operate a signal scanner, for example, at the highest possible speed for fully accurate information. The falling edge can also be used to command the instrument, via its delayed command facility, at the same time. See Section 4.1.4.5.

4.1.4.3 Hold Reading: Pin 40, HOLD, may be externally held in a low state if it is desired to stop the instrument from reaching its normal free-run mode. When pin 40 is taken low the instrument will complete any reading in progress, followed by storing and displaying it until pin 40 is taken high or released, or until an external read command is applied.

4.1.4.4 Read Command. A falling edge on pin 41, COMMAND, instructs the instrument to take one reading immediately if, and only if, pin 40 HOLD is already held low. The instrument inhibits commands that are applied before conversion in progress is complete. Fig. 4:1 shows the relationship of COMMAND and PRINT COMMAND to the integration cycle.

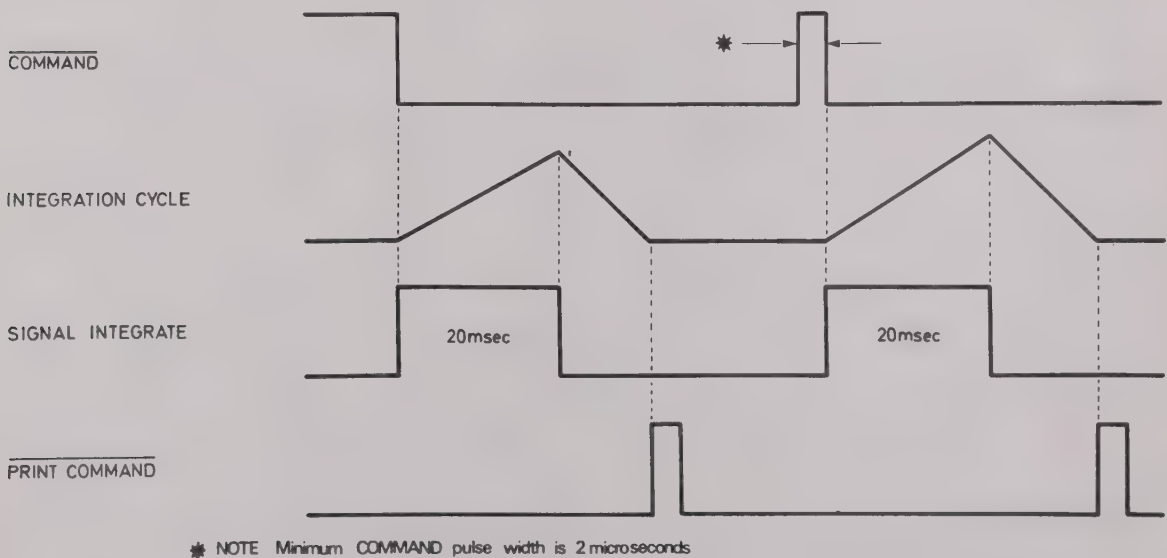


FIG. 4:1

4.1.4.5 Delayed Command: If pin 44, DELAY is held at logic 0 while an external command is applied, then the command will be automatically delayed by a period of time equal to the settling time of the integration filter.

Provided pin 44 is held low, this means that the instrument can be commanded at the same instant that new signal information is applied to the front panel terminals. A particularly useful example of this is where the Model 1059 is used in conjunction with a signal scanner, the same command being used for stepping or switching the scanner, as for commanding a reading to be taken, see Fig. 4:2.

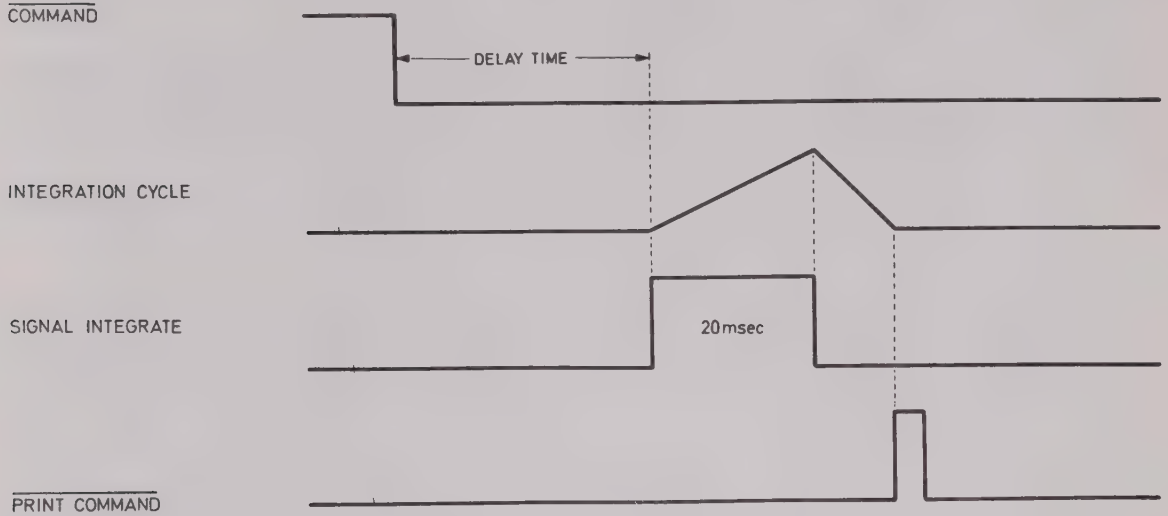


Fig.4-2

For maximum read rate in a closed-loop system, the command could be the falling edge of pin 43, SIGNAL INTEGRATE, see Fig. 4:3.

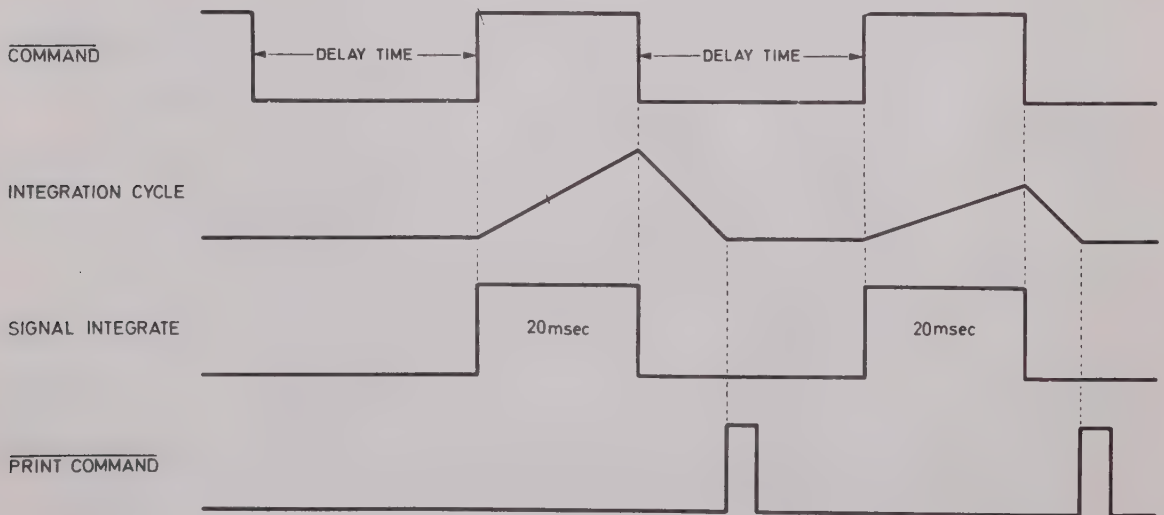


Fig.4-3

4.1.4.6 Front Panel Control: If pin 38 is held low the front panel control push buttons are inhibited, i.e. PRINT INHIBIT, MANUAL and HOLD.

4.1.4.7 'Low' State Reference: All digital outputs and command lines are referred to digital COMMON on pin 39. Maximum fan-in is 1 TTL load, maximum fan-out capability is 2 TTL loads.

4.2 THREE-STATE LOGIC OUTPUT

On option B05 a 3 state (or "Tri-state"*) output is standard. Upon application of a logic low to pin 42 $\overline{\text{PRINT INHIBIT}}$ or upon depressing the Print Inhibit button if enabled (see 4.1.4.6), all active BCD and control lines are inhibited. The output lines are forced to a "third state" which is a very high impedance OFF state.

The instrument can therefore be permanently connected to logic highways or bus-bars in a system and then, by application of a single logic 0 to pin 42, electrically disconnected at will. An important example of this would be where the BCD outputs of several instruments are connected in parallel to a printer: a simple single pole switch could be used to select the output from a particular instrument for printing.

* Trade mark: National Semiconductor Inc.

SECTION 5

SPECIFICATION VERIFICATION

5.1 DESCRIPTION

The following steps form a routine for checking that the instrument is working within its specified accuracy where the intention is not to re-calibrate internally. It is thus useful for incoming inspection or routine calibration checks.

It is recommended that due to the wide measurement capability of the instrument, only those aspects of the specification relevant to normal use be verified. This saves considerably in both time and calibration equipment, especially where the 1 μ V resolution or hf AC performance are not required. For general purpose measurements, the whole procedure should be followed to verify the entire specification. Space is provided to tick against each step checked.

5.2 INSTRUMENT REQUIREMENTS (DC VOLTAGE)

A DC source is required of accuracy at least three times better than the accuracy being verified, from 100 mV to 1000 V.

Examples:

Julie Research DVS 106
Optimation AC 126/PA 226 (For AC and DC)

5.3 PROCEDURE – DC VOLTAGE PERFORMANCE

5.3.1 Turn on the instrument to be checked and allow at least one hour, preferably two hours, to warm up.

5.3.2 Zero the instrument by the following procedure:

- 1 Ensure link is fitted between Guard and Input Volts Lo. Connect Hi to Lo with a short link.
- 2 Switch the instrument to the 10 V DC range and adjust the 'pA' offset control on the front panel of the instrument for 0.0000 bouncing polarity.
- 3 Switch the instrument to the 100 mV DC range and adjust the 'μV' offset control on the front panel of the instrument for 0.000 bouncing polarity.
- 4 Repeat steps 2 and 3 until the instrument reads zero in both ranges without further adjustment.

5.3.3 Switch instrument to 1 volt range. Check the instrument reads $.00000 \pm .00002$.

5.3.4 Apply +1.00000 volts check reading is
 $+1.00000 \pm .00007$.

5.3.5 Apply -1.00000 volts, check reading is
 $-1.00000 \pm .00007$

If 5.3.3 to 5.3.5 are passed this indicates that most of the instrument is working correctly. If it is failed by more than 0.3% then it is likely that there is a fault rather than a calibration error.

5.3.6 Select 10 V range Apply +10.0000 V, check reading is
 $+10.0000 \pm .0007$

5.3.7 Apply -10.0000 V, check reading is
 $-10.0000 \pm .0007$

5.3.8 Select 100 V range Apply +100.000 V check reading is
 $+100.000 \pm .007$

5.3.9 Apply -100.000 V, check reading is
 $-100.000 \pm .007$

- 5.3.10 Select 1, kV range Apply +1000.00 V, check reading is
+1000.00 $\pm$.15
- 5.3.11 Apply -1000.00 V, check reading is
-1000.00 $\pm$.15
- 5.3.12 Select 100 mV DC. Turn DC source down to zero. Allow several minutes for thermal e.m.f.'s to disappear or stabilize.
Adjust μ V offset for display of 0.000
Apply +100.000 mV, check reading is
+100.000 $\pm$.008
- 5.3.13 Apply -100.000 mV, check reading is
-100.000 $\pm$.008
(If changing polarity involves reversing leads, check zero again as thermal e.m.f.s may have changed. If possible reverse polarity at a higher voltage level so as not to "reverse thermals).

This concludes checking of accuracy.
- 5.3.14 For linearity check, select 1 volt range.
Apply +0.10000 V, check reading is
+0.10000 $\pm$.00002
- 5.3.15 Apply +0.50000 V, check reading is
+0.50000 $\pm$.00004
- 5.3.16 Apply +1.00000 V, check reading is
+1.00000 $\pm$.00007
- 5.3.17 Apply +1.90000 V, check reading is
+1.90000 $\pm$.000012
DC Verification is now complete

5.4 INSTRUMENT REQUIREMENTS (AC VOLTAGE)

Optimation AC125/PA1182
Hewlett Packard 745/746
Optimation AC126/PA 226 (AC and DC)

To verify the performance in the DC coupled mode a voltage source is required capable of producing approximately 1 volt DC.

5.5. PROCEDURE DC VOLTAGE PERFORMANCE

- 5.5.1 Carry out 5.3.1 and select ACV
- 5.5.2 Connect Hi to Lo with a short link. Check instrument reads 20 digits maximum on all ranges.
- 5.5.3 Apply 1.00000 volts r.m.s. at 40 Hz, 3 kHz, 30 kHz in turn. The readings are respectively:
- $1.00000 \pm .00200$
 $1.00000 \pm .00200$
 $1.00000 \pm .00400$

If this test is failed by more than about 3% at 3 kHz or 2% at 30 kHz there is probably a fault rather than a calibration error.

- 5.5.4 Repeat 5.5.3 for 10 V range with 10 V_{r.m.s.} input. The readings are:
- | |
|-----------------|
| 10.0000 ± .0200 |
| 10.0000 ± .0200 |
| 10.0000 ± .0400 |

- 5.5.5 Repeat 5.5.3 for the 100 V range with 100 V r.m.s. input. The readings are:

$100.000 \pm .200$

$100.000 \pm .200$

$100.000 \pm .400$

- 5.5.6 Repeat 5.5.3 for the 1000 V range with 700 V r.m.s. (1,000 V pk) input except at 30 kHz which is not specified. The readings are:

700.00 ± 1.78

700.00 ± 1.78

- 5.5.7 To check the DC coupled performance of the instrument it is only necessary to check that it responds equally to positive and negative signals as follows:

Switch to 1 V range and select DCV + ACV

Apply approximately 1 volt DC with positive to Hi and negative to Lo, and note the reading.

Reverse the connections and check that the same reading, within ± 0.00200 , is obtained.

5.6 INSTRUMENT REQUIREMENTS (OHMS)

A set of standard resistors is required covering $1k\ \Omega$ to $10M\ \Omega$

5.7 PROCEDURE – OHMS PERFORMANCE

- 5.7.1 Carry out steps 5.3.1 and 5.3.2

- 5.7.2 Select $k\Omega$, $1k\ \Omega$, range connect Hi to Lo with a short link. Check the instrument reads .00010 maximum.

- 5.7.3 Connect the $1k\ \Omega$ resistor to the input terminals. Check the reading is $1.00000 \pm .00020$

NOTE: If long leads are used to the resistors these must be accounted for either by nulling out the lead resistance with the 'µV' offset control or by computing the difference between measured readings and measured lead resistance.

- 5.7.4 Select $10k\Omega$, connect the $10k\Omega$ resistor. Check reading is:

$10.0000 \pm .0014$

- 5.7.5 Select $100k\Omega$, connect the $100k\Omega$ resistor. Check reading is:

$100.000 \pm .014$

- 5.7.6 Select $1,000k\Omega$, connect the $1,000k\Omega$ resistor. Check reading is,

$1000.00 \pm .34$ (after allowing adequate settling time)

- 5.7.7 Select $10M\Omega$, connect the $10M\Omega$ resistor. Check reading is:

$10.0000 \pm .0500$ (after allowing adequate settling time)

5.8 INSTRUMENT REQUIREMENTS (DC CURRENT)

A DC current source is required of accuracy at least three times better than the accuracy being verified from 1 mA to 1,000 mA.

5.9 PROCEDURE – DC CURRENT PERFORMANCE

- 5.9.1 Carry out steps 5.3.1 and 5.3.2

- 5.9.2 Select DCI 1mA range. With no input connected check the instrument reads

$.00000 \pm .00002$

5.9.3 Connect the output of the current source to the current input terminals of the instrument.

Apply +1.00000 mA, check reading is:

+1.00000 $\pm$.00017

Apply -1.00000 mA, check reading is

-1.00000 $\pm$.00017

5.9.4 Select 10mA range. Apply +10.0000 mA, check reading is

+10.0000 $\pm$.0017

Apply -10.0000 mA, check reading is

-10.0000 $\pm$.0017

5.9.5 Select 100 mA range. Apply +100.000 mA, check reading is

+100.000 $\pm$.017

Apply -100.000 mA, check reading is

-100.000 $\pm$.017

5.9.6 Select 1,000 mA range. Apply +1000.00 mA, check reading is

+1000.00 $\pm$.34

Apply -1000.00 mA, check reading is

-1000.00 $\pm$.34

5.10 INSTRUMENT REQUIREMENTS (AC CURRENT)

An AC current source is required of accuracy at least three times better than the accuracy being verified, from 1 mA to 1000 mA.

To verify the performance in the DC coupled mode a current source is required capable of producing approximately 1 mA DC.

5.11 PROCEDURE – AC CURRENT PERFORMANCE

5.11.1 Carry out steps 5.3.1

5.11.2 Select ACI, 1 mA range. With no input connected check the instrument reads

.00020 maximum

5.11.3 Connect the output of the current source to the current input terminals of the instrument.

Apply 1.00000 mA r.m.s. at 40 Hz, 3 kHz, 30 kHz.. Check readings are respectively:

1.00000 $\pm$.00200

1.00000 $\pm$.00200

1.00000 $\pm$.00400

- 5.11.4 Repeat 5.11.3 for the 10 mA range with 10 mA r.m.s. input. Check readings are:

$10.0000 \pm .0200$

$10.0000 \pm .0200$

$10.0000 \pm .0400$

- 5.11.5 Repeat 5.11.3 for the 100 mA range with 100 mA r.m.s. input except at 30 kHz which is not specified. Check readings are:

$100.000 \pm .200$

$100.000 \pm .200$

- 5.11.6 Repeat 5.11.3 for the 1000 mA range with 1000 mA r.m.s. input except at 30 kHz which is not specified. Check readings are:

1000.00 ± 2.00

1000.00 ± 2.00

- 5.11.7 To check the DC coupled performance of the instrument it is only necessary to check that it responds equally to positive and negative signals as follows:

Switch to 1 mA range and select DCI + ACI,

Apply approximately 1 mA dc with positive to Current Input Hi and negative to Lo, and note the reading

Reverse the connections and check that the same reading, within $\pm .000200$ is obtained.

5.12 INSTRUMENT REQUIREMENTS (EXTERNAL REFERENCE)

A stable DC source of approximately 2V.

A stable DC source of approximately .3V.

5.13 PROCEDURE EXTERNAL REFERENCE

Make sure that the DC signal measurement is working correctly as in Section 5.3. Switch the rear panel slide switch to external reference.

- 5.13.1 Connect Signal Hi to Reference Hi and Signal Lo to Reference Lo. Switch Guard to Local, and to 1V DC range apply approximately +2V to the commoned signal and reference inputs. Check the reading is:

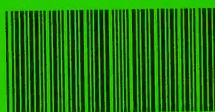
$1.00000 \pm .00011$

- 5.13.2 Repeat 5.13.1 with +0.3 volts. Check reading is

$1.00000 \pm .00016$

If these conditions are met then the external reference performance is functioning correctly.

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MA23498